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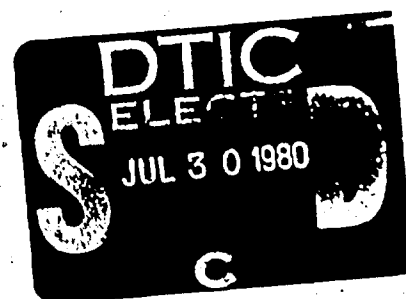
SYSTEM PLANNING CORPORATION

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THE LOCAL ENVIRONMENT
RESULTING FROM A MASSIVE
NUCLEAR ATTACK ON
WHITEMAN AIR FORCE BASE

FINAL TECHNICAL REPORT

SPC 537



April 1980

Charles W. Hulburt
Cynthia A. Yutko
Roger J. Sullivan

Sponsored by
Federal Emergency Management Agency
Washington, D.C. 20472
Contract DCPA01-78-C-0280
Work Unit Number 4222E
Contracting Officer's Technical Representative
Dr. David W. Bensen

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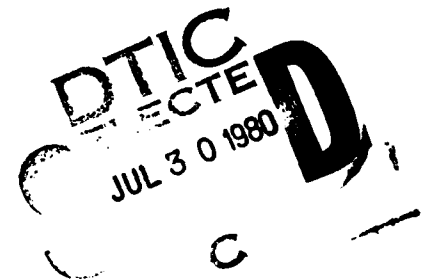
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FEMA REVIEW NOTICE

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I. EXECUTIVE SUMMARY

A. PURPOSE

This study was prepared by System Planning Corporation for the Federal Emergency Management Agency (FEMA), Washington, D.C. The study examines the potential blast and fallout damage that would be sustained by the 15 counties surrounding the Whiteman Air Force Base in Missouri following a nuclear attack against the associated Minuteman missile silos. The study also provides recommendations concerning the shelters that would be required to protect the population of these 15 counties from blast effects and heavy fallout.

The study was performed in consonance with the new emphasis that FEMA is giving to nuclear civil protection in counterforce areas. It is intended to be a prototype for analyses of areas containing other U.S. counterforce targets, notably the other five Minuteman wings, the Titan missiles, the Strategic Air Command bases, and the strategic submarine bases.

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B. BACKGROUND

Previous considerations of possible Soviet nuclear attack patterns led to the conclusion that inhabitants of those counties in the vicinity of strategic offensive missile sites or other critical military installations are potentially subject to minimum warning of attack and thus may have less time to react than the population as a whole.¹ Most strategists believe that counterforce targeting will take precedence over almost any other kind in a general engagement and that initial strikes may be made up solely of such engagements.

¹R.J. Sullivan et al., Civil Defense Needs of High Risk Areas in the United States, System Planning Corporation, SPC Report 409, March 1979 [Ref. 1].

SPC Report 409 [Ref. 1], which included a nationwide analysis of the effects of a counterforce attack, concluded that civil defense could be very effective in drastically decreasing fatalities from such an attack. Following that study, it was decided that individual counterforce areas should be studied in more detail. The present report on the Whiteman Air Force Base missile complex describes the first of these detailed analyses.

C. APPROACH

It is assumed that each Minuteman silo is attacked with one 1-MT nuclear weapon that is surface-burst exactly on target. On detailed maps of the 14 counties containing silos, contours were drawn corresponding to peak overpressures of 2, 5, 15, and 55 pounds per square inch (psi). These levels were chosen because they represent mean values that would produce, respectively, (1) light damage, (2) fatalities for unprotected people, (3) fatalities for people in expedient blast shelters, and (4) fatalities for people in better quality (15 to 55-psi) blast shelters [Ref. 1].

In this study, the counties surrounding the Whiteman Air Force Base complex are examined on an individual basis. A county-by-county analysis is presented in order of the degree of blast and fallout damage that each county is expected to incur, with those counties likely to receive the severest damage presented first.

In order to make the proper recommendations for relocation of the population, several factors were considered. First, the towns and cities that are close to the targets were identified, together with the blast protection they would require. Second, if populated areas would be evacuated, terrain and other features were considered. Third, mines and caves were identified and considered for use as shelters from blast and fallout. And fourth, areas were identified where a large number of people might better be relocated because of radioactive fallout if time were available.

D. FINDINGS

There is a possibility of only tactical warning. Therefore, the in-place distribution of population as a function of overpressure was defined.¹ In the blast risk areas, where people would not have time to evacuate, two types of shelters were considered. The first is a blast shelter that can withstand overpressures up to 15 psi. Approximately 6 percent of the population live within the 15-psi or greater overpressure zones around Minute-man sites. Nearly all of those people could evacuate on foot within 15 minutes² from this zone to an area where 15-psi overpressure or less is expected. Second, 5-psi overpressure shelters would be placed in areas that would receive overpressures from 2 to 5 psi.

Of the counties that would be directly affected by blast under the assumed attack, nine of them are judged to require 15-psi blast shelters in some locations. Two additional counties would need 5-psi shelters in some locations, and all counties would need some fallout protection.

Recommendations as to these kinds of requirements are made in each of the county analyses. One reason that evacuation out of certain areas may be impossible has to do with terrain in surrounding areas. Many towns are near large bodies of water, and evacuation toward these areas would be undesirable. In other cases, the road networks are not suitable for evacuation of large numbers of people within a limited warning time. If people did stay in the blast areas, special requirements for life support for extended occupancy would be needed. In many cases, road networks would be filled with debris from the blast subsequent to the attack. The people probably could not spend time clearing the road of obstacles since to avoid the effects of fallout radiation they would only be able to remain outdoors for limited periods of time. Thus, unless evacuation could be carried out

¹Throughout this report, "overpressure" should be understood to mean peak overpressure.

²It is assumed that an intense international crisis and a "surge" of civil defense preparation, including extensive public information, precede the evacuation order. Human behavioral issues are beyond the scope of this report, but are discussed in References 1 and 2.

in very short periods (e.g., by air), they would have to remain under shelter protection for extended times.

Residents of areas subject only to fallout effects would have more time to get to their shelters after the initial detonations and would also be able to travel along roads and highways. Therefore, life support for extended occupancy would be of more concern for the people in the missile complex areas, who would have shorter reaction times than those in areas that would be subject to fallout alone.

Though this study was confined to those 15 counties in which there would be blast effects as a result of an attack against the Whiteman Air Force Base complex, it is clear that high fallout protection factor shelters (from 200 to 1000) are needed downwind under prevailing wind conditions.¹ The wind direction would deviate significantly from west to east about 10 to 20 percent of the time, which implies that such shelters would be of advantage in what is usually the upwind direction as well.

There are at least five counties (Morgan, Cooper, Henry, St. Clair, and Cass) which contain caves or mines that could be used as blast and fallout shelters. All the caves or mines would require extensive modifications if they were to be used as shelters (e.g., those close to high-overpressure areas would require blast doors, forced ventilation, and associated radiation protection). Caves or mines used as fallout shelters alone would require only radiation protection associated with ventilation systems. It should be noted that mines in Henry County and St. Clair County may be subject to flooding (based on available data).

For estimating the fallout intensity at a downwind distance of greater than about 50 miles from a group of surface bursts, currently utilized computer models are probably about as accurate as more sophisticated methods.

¹ Some of the counties that were not included in the blast damage analysis but would need high fallout protection factor shelters are Howard, Boone, Cole, Miller, and Camden.

However, for estimating the fallout intensity close to, or within, the group of burst locations, such models are not adequately descriptive, and more detailed individual detonation analysis should be used. Models such as TENOS or SIDAC in the individual detonation mode, or PROFET or SEER, should be satisfactory. A cross-check with DELFIC may be worthwhile in some instances.

E. RECOMMENDATIONS

1. Analyses of potential blast and fallout effects should be performed for the remaining five Minuteman areas, plus other areas containing counterforce targets.

2. Further surveys should be made of all mines and caves within or adjacent to the Whiteman area to determine their suitability as shelters.

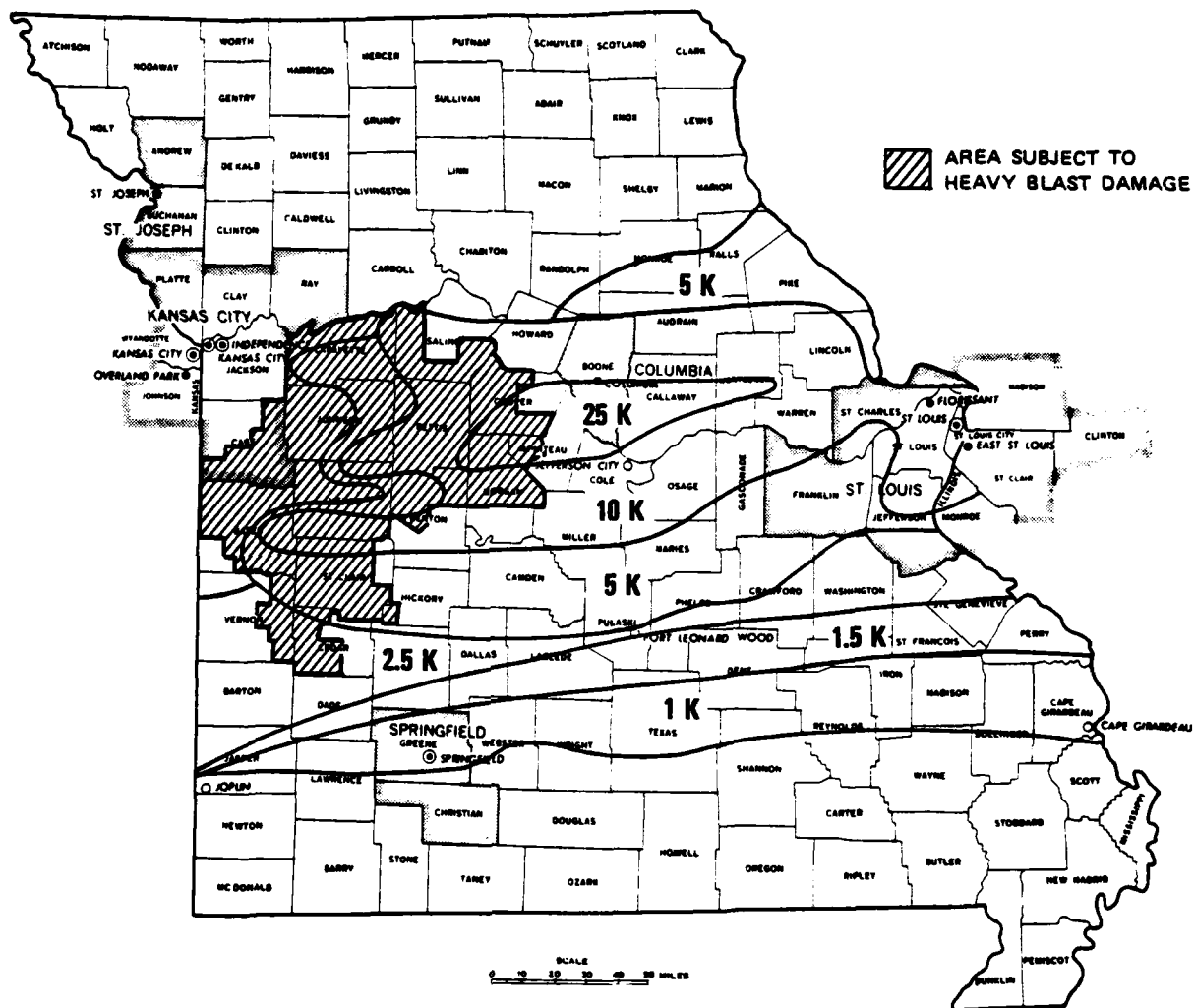
II. ATTACK ENVIRONMENT

It is assumed that surface detonation of 1-MT weapons would occur at each of the 150 missile sites; approximately 6,000 mi² surrounding Whiteman Air Force Base would be affected by blast damage. The following sections contain detailed information on the blast-risk areas.

A. INITIAL EFFECTS

There are 15 counties that would be physically affected by blast associated with attacks on Minuteman silos. Each county experiences various amounts of damage depending on how many Minuteman sites are in or around the county and at what distance from the blast they are located. Figure 1 shows approximately what areas are affected by heavy blast damage in the counties surrounding Whiteman Air Force Base.

For convenience in accomplishing the assessment, the 15 counties were placed in three blast-damage categories. The first category contains the counties that would receive "severe" damage over most of the total area of that county. These counties are: (1) Johnson, (2) Pettis, (3) Henry, (4) Lafayette, (5) St. Clair, and (6) Bates. The second category contains the counties that receive severe damage over a moderate portion of the total area from an attack on the base. These counties are: (7) Morgan, (8) Saline, (9) Cooper, (10) Benton, and (11) Cedar. The third category includes counties that receive only limited damage as compared to the total area of the county. These counties are: (12) Cass, (13) Vernon, (14) Moniteau, and (15) Hickory.



SOURCE: Reference 1.

FIGURE 1. MISSOURI, BLAST-RISK AREAS AND ESTIMATED FALLOUT PATTERN FOR REPRESENTATIVE MARCH WINDS (Accumulated Dose in Thousands of Roentgens)

The radius of blast damage of 15-psi overpressure or greater extends as far as 1.5 mi; within this radius, there would be destruction of all except specially designed facilities. In most cases, there are no major populated areas in this zone.

The radius of 5-psi overpressure extends out approximately 3 miles from the point of detonation. From 15-psi down to 5-psi overpressure, severe damage will occur to commercial-type buildings. The total area that receives the effects of a 5-psi or greater overpressure is approximately 3,590 mi², which represents 60 percent of the total area examined.

The areas that would be subjected to at least 2 psi, or surrounded by 2 psi or greater overpressure, are defined as the "areas of concern". The radius of 2-psi overpressure extends out five miles from the point of detonation. From the 5-psi overpressure radius to the 2-psi overpressure radius, moderate damage would occur to commercial-type buildings and severe damage would occur to small residences.

The analysis of the blast regions is focused on the areas of concern shown in Table 1. The table also gives the different degrees of psi overpressure by area. A greater overpressure requires more blast protection. For most of the evaluation, we assume that people would be evacuated from extremely dangerous blast regions. The blast regions of each county are described in Chapter IV, and a county-by-county analysis is provided.

B. SAFE AREAS

In the evaluation of "safe areas" terrain and other geographical features were considered in defining usable areas for population evacuation, that is, those areas outside the 2-psi contour, excluding lakes, marshes, and difficult terrain. Table 2 shows how much usable area there would be in each county.

The analysis also looks at how much area is safe from the different levels of overpressure within the areas of concern. For example, in Pettis County, the area of concern is the whole county (679 mi²). Of this area, 164 mi² is safe from 5-psi overpressure; however, within this safe zone,

TABLE 1. MISSOURI, APPROXIMATE AREAS AFFECTED BY 1-MT BLASTS AT EACH OF THE MINUTEMAN SITES

		County									
Area Affected By Blast	Total Area of County ^a	Johnson	Pettis	Bates	Henry	Lafayette	St. Clair	Morgan	Saline		
		828	679	841	734	632	697	592	757		
	Area of Concern (2 psi or greater)	808	679	618	734	480	559	360	340		
	5 psi or greater	573	515	400	390	310	245	225	205		
	15 psi or greater	190	165	124	105	90	95	70	60		
	55 psi or greater	65	53	43	35	30	32	25	19		

		County									
Area Affected By Blast	Total Area of County ^a	Cooper	Benton	Cedar	Cass	Vernon	Moniteau	Hickory			
		568	735	496	698	838	419	377			
	Area of Concern (2 psi or greater)	390	305	195	260	200	130	5			
	5 psi or greater	195	180	111	110	110	20	0			
	15 psi or greater	65	50	35	30	33	15	0			
	55 psi or greater	25	18	12	10	12	4	0			

^aAreas are in mi²

TABLE 2. MISSOURI, APPROXIMATE SAFE AREAS FROM BLAST IN THE 15 COUNTIES SURROUNDING WHITEMAN AIR FORCE BASE

		County							
		Johnson	Pettis	Bates	Henry	Lafayette	St. Clair	Morgan	Saline
Area of Concern ^a		808	679	618	734	480	559	360	340
Safe Area Within Area of Concern	From 2 psi	Includes Unusable	4	1.2	187	3	55	8	2
		All Usable	12	4	90	3	20	5	2
	From 5 psi	Includes Unusable	164	218	344	170	314	135	135
		All Usable	235	190	220	150	255	90	120
	From 15 psi	Includes Unusable	514	494	629	390	464	290	280
		All Usable	618	545	480	362	392	230	256
	From 55 psi	Includes Unusable	626	573	699	450	527	335	321
		All Usable	743	660	544	418	447	272	295

^aAreas are in mi²

TABLE 2. (CONTINUED)

			County						
			Cooper	Benton	Cedar	Cass	Vernon	Moniteau	Hickory
Area of Concern ^a			390	305	195	260	200	130	5
Safe Area Within Area of Concern	From 2 psi	Includes Unusable	18	2	3	20	1	0	0
		All Usable	10	2	2.5	16	0	0	0
	From 5 psi	Includes Unusable	195	125	84	150	90	110	5
		All Usable	100	80	70	135	75	100	4
	From 15 psi	Includes Unusable	325	255	160	230	167	115	5
		All Usable	220	206	135	210	143	102	4
	From 55 psi	Includes Unusable	365	287	183	250	188	126	5
		All Usable	258	237	154	230	163	113	4

^aAreas are in mi²

some areas have difficult terrain or no road access. Therefore, only 110 mi² can be considered safe and usable.

The percent of safe area within the area of concern for each level of overpressure is shown graphically for each county in Chapter IV. These safe areas are safe from the specified level of overpressure, but they are not necessarily safe from fallout.

III. SHELTERING REQUIREMENTS

A. EVACUATION TRAVEL TIMES

Since there is at least some possibility of a preemptive attack against the Whiteman complex and associated command, control, and communications (C³) and a stronger possibility that alerts may be of such long duration that the working portion of the local population and their immediate families would prefer not to relocate, this analysis is based on a warning time of 15 minutes for purposes of deducing travel times and possible or probable shelter occupancy requirements.¹

B. BLAST

In the county-by-county analysis (Chap. IV), recommendations are made for the populated areas that are in severe blast regions. We assume that the few people who live within 1 or 2 miles of detonation points will be able to evacuate into safer areas within 15 minutes following warning of attack. Therefore, we define two types of shelters for those people requiring blast protection. First, a "15-psi blast shelter" is defined as being capable of withstanding peak overpressures up to 15 psi. The second shelter, a "5-psi overpressure shelter" is capable of withstanding peak overpressures up to 5 psi. Since high radiation would be experienced in the blast regions, both of these shelter types would have to incorporate effective fallout protection as well as blast protection.

¹ It is assumed that an intense international crisis and a "surge" of civil defense preparation, including extensive public information, precede the evacuation order. Human behavioral issues are beyond the scope of this brief report; see References 1 and 2 for a discussion of these issues.

C. FALLOUT

Figure 1 also shows the fallout pattern assumed in the study based on a set of March winds. Evaluation of probable annual wind variation leads to the conclusion that there is a moderate to high probability of extremely heavy fallout (25,000 to 100,000 rad cumulative over the 2-week period following the attack) in the eastern one-half to two-thirds of the counties within the Whiteman Air Force Base area and some possibility each year in the western one-third to one-half of the complex. Figure 1 was extracted from SPC Report 409, Special Civil Defense Needs of the United States [Ref.1].

The counties are categorized differently with respect to fallout than they are for blast damage because those counties to the east of the missile complex would receive more radiation.

The counties subject to a high probability of heavy fallout are: (1) Cooper, (2) Morgan, (3) Moniteau, (4) Pettis, (5) Saline, and (6) Benton. The counties subject to a moderate probability of heavy fallout are: (7) Johnson, (8) Henry, (9) St. Clair, (10) Bates, (11) Lafayette, and (12) Hickory. The counties having a relatively low probability of heavy fallout would be (13) Cedar, (14) Vernon, and (15) Cass.

In general, fallout protection factors of 250 to 1,000 are recommended, with the higher protection factors associated with the areas where heavy fallout is expected under any wind condition. It is recognized that relocation of as large a proportion of the population as possible from these areas may be the best alternative provided there is adequate warning time.

D. IN-PLACE DISTRIBUTION OF POPULATION

A large number of towns in the Missouri blast region are in 5- to 15-psi overpressure areas. It is assumed that the residents can relocate outside of this area. Some exceptions are heavily populated towns where a large flux of people out of the town may be impossible with short warning.

Chapter IV discusses in-place distribution of the population in areas that cannot handle large evacuations out of the town.

E. LIFE SUPPORT FOR EXTENDED OCCUPANCY

Within the areas receiving significant blast damage, radiation will also be high. People would have to stay in their shelters for a few weeks before they could safely emerge. Careful preparation would have to be made in peacetime for life support during the post-attack period, especially with respect to water, ventilation, sanitation, medical supplies, food, etc. Such preparation should be based on the many studies of these parameters that have been performed over the years, especially by FEMA/DCCA.

IV. INDIVIDUAL COUNTY ANALYSIS

Analysis on a county-by-county basis for blast and fallout protection is presented in this chapter.¹ The counties are addressed in order of their requirements for protection, beginning with those likely to sustain the most damage and proceeding to those expected to receive the least damage. One figure accompanies each county analysis. This figure shows what percent of safe area there is within the area of concern for various peak overpressures.

Exceptions to the general results are pointed out on an individual county basis. Potential shelters that could be utilized (e.g., local mines) are discussed in the analysis. In general, mines could accommodate a majority of the population in Henry, St. Clair, Cass, Cooper, and Morgan counties provided there were hours or days of warning time. Given short warning times, only in St. Clair and Cooper counties would there be any possibility of evacuating people to the mines. Further evaluation, however, should be made of the feasibility of using the mines in Henry and St. Clair counties as shelters, because they may be subject to flooding.

Note that in the context of the State of Missouri as a whole, some of the counties outside the blast area to the east of Whiteman may have more casualties from fallout alone than some of the western counties from both blast and fallout. This implies that priorities on a statewide basis, even when considering only counterforce attacks, might shift to counties subject to heavy fallout outside the complex rather than counties which would suffer lower combined casualties from blast and fallout.

¹Some of the counties that were not included in the blast damage analysis but would need high fallout protection factor shelters are Howard, Boone, Cole, Miller, and Camden.

An illustrative county map (not an actual county) representative of the variations found in the counties examined in Missouri is shown in Figure 2. This figure is included not only as a means of showing the elements addressed in the evaluation, but also to indicate the methods of analysis utilized in arriving at the overall picture on a county-by-county basis.

In determining areas available for shelters at varying blast protection levels, the first step was that of determining how much area within the area of concern is expected to be subjected to 2-psi or less overpressure. The area of concern does not include the entire county in several cases, since some of them have sites over only a quarter or half of the county. In cases such as the one depicted in Figure 2, however, the entire county is taken as the area of concern because there are only narrow avenues of safe areas into adjacent counties. The regions that would not be appropriate for building shelters were then subtracted. Areas that contain lakes, rivers, land subject to flooding, and hilly areas with limited road access were eliminated. Figure 3 depicts the available usable areas at the various psi levels; the solid line does not take terrain into consideration, while the dashed line (showing less available area) does. In this illustrative case, there is more terrain which is unusable than the average throughout the actual counties analyzed because a deliberate attempt was made to show all types of undesirable terrain.

The percent of safe areas indicated in Figure 3 are based on three levels of overpressure: 2 psi, 5 psi, and 15 psi. The diagram consists of straight line segments, although it is obvious that the plots would be curves if sufficient points were evaluated.

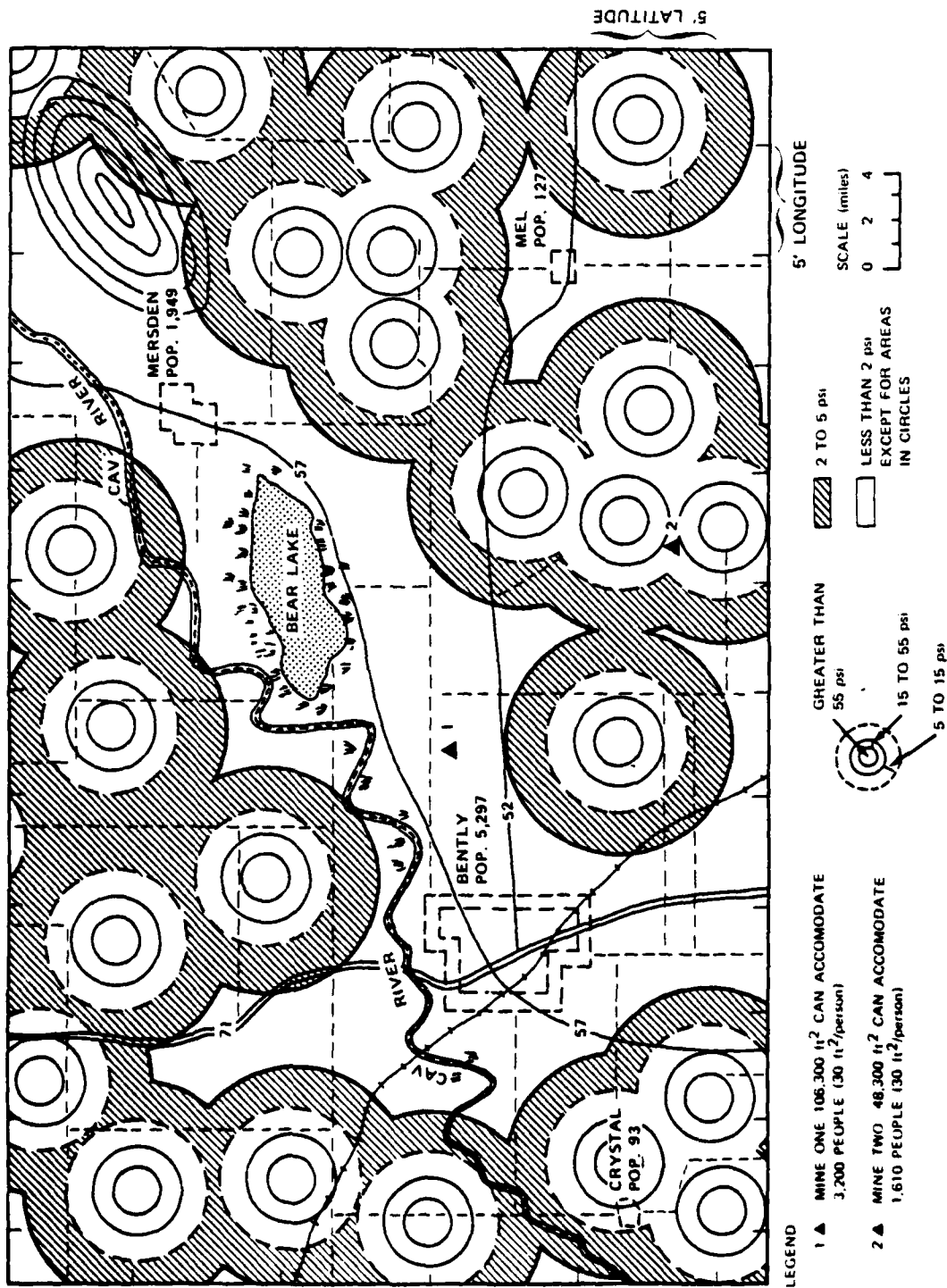


FIGURE 2. ILLUSTRATIVE COUNTY MAP (This fictitious map illustrates typical features found on maps of counties in the area of Whiteman Air Force Base, Missouri.)

ILLUSTRATIVE COUNTY MAP

AREA OF CONCERN: THE AREA THAT IS AFFECTED
AND BOUNDED BY A 2-psi BLAST OVERPRESSURE

AREA OF COUNTY: 1,580 mi²

AREA OF CONCERN: 1,580 mi² (100% OF THE COUNTY)

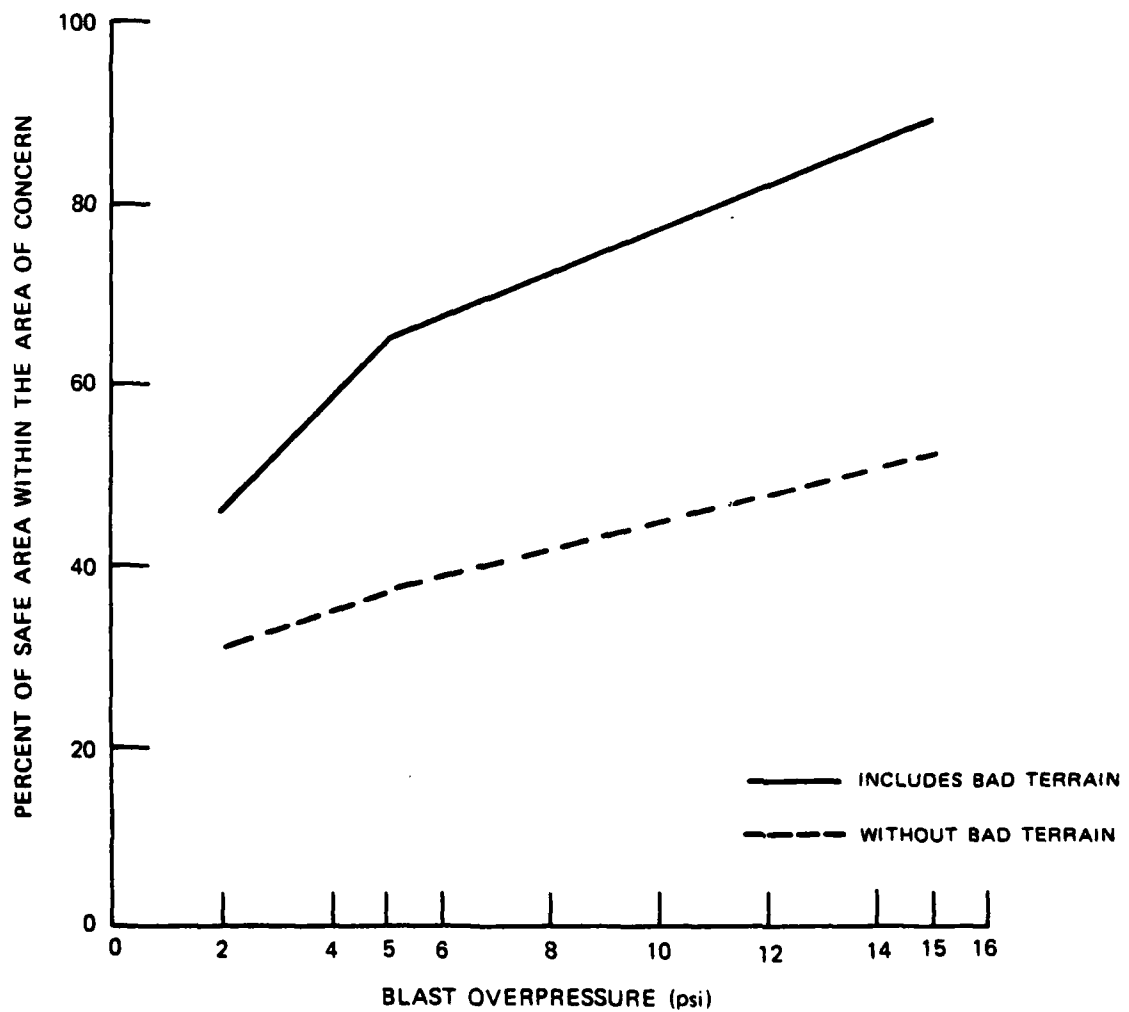


FIGURE 3. SAFE AREA WITHIN AREA OF CONCERN

In the actual evaluation a planimeter was utilized to determine the various areas. For the illustrated county map the data is as follows:

Total Area of County			1,580 mi ²
Area of Concern			1,580 mi ²
Area Affected By Blast	5 psi or greater		540 mi ²
	15 psi or greater		181 mi ²
	55 psi or greater		55 mi ²
Safe Area Within Area of Concern	From 2 psi	Includes Unusable	740 mi ²
		All Usable	490 mi ²
	From 5 psi	Includes Unusable	1040 mi ²
		All Usable	590 mi ²
	From 15 psi	Includes Unusable	1400 mi ²
		All Usable	815 mi ²
	From 55 psi	Includes Unusable	1525 mi ²
		All Usable	975 mi ²

Of the area that cannot be used because of difficult terrain, 20 percent is water, 25 percent is subject to flooding, 15 percent is marshland, and 40 percent is mountainous, hilly land, and has limited road access.

The sections which follow relate to the actual Missouri counties and give their characteristics.

A. PETTIS COUNTY

There are approximately 35,000 people in Pettis County. This is one of the worst blast damage and fallout areas in the Missouri blast region. The blast damage in this county would be so extensive that after the attack occurred the road network would be heavily damaged. Life support for extended occupancy would therefore be necessary. If the population were to stay in place, shelters would be required. Both 5-psi overpressure shelters and 15-psi blast shelters would be needed in many of the blast areas in Pettis County. The locations of these shelters would require that they have fallout protection factors of 200 or more.

A majority of the Pettis population (22,850) live in the Sedalia area. For the most part, 5-psi overpressure shelters would be needed for three-fourths of the population in this area, and all of the population would need heavy fallout protection.

Some of the severe blast damage areas in Pettis County would need 15-psi blast shelters for their population; these areas are Houstonia (pop. 320); LaMonte (pop. 900); Green Ridge (pop. 400); Hughesville (pop. 100); and Smithon (pop. 400). All of these towns are located within areas that receive 5-psi or greater overpressure.

The remaining 10,000 people are dispersed throughout the county. Approximately 6,000 of these people are in areas where 15-psi blast shelters would be required. Such shelters should be built in a central location convenient to the surrounding population such that the people could walk or drive there with only a 15-minute warning. The other 4,000 people are in areas that would require 5-psi overpressure shelters. These shelters should also be centrally located among the population such that the people could walk there within 15 minutes or less.

Figure 4 shows the percent of safe area within the area of concern for Pettis County. Considering that the area of concern is the total area of the county, the figure shows that there is hardly any safe area in Pettis County, especially for the lower overpressures.

PETTIS COUNTY

AREA OF CONCERN: THE AREA THAT IS AFFECTED
AND BOUNDED BY A 2-psi BLAST OVERPRESSURE

AREA OF COUNTY: 679 mi^2

AREA OF CONCERN: 679 mi^2 (100% OF THE COUNTY)

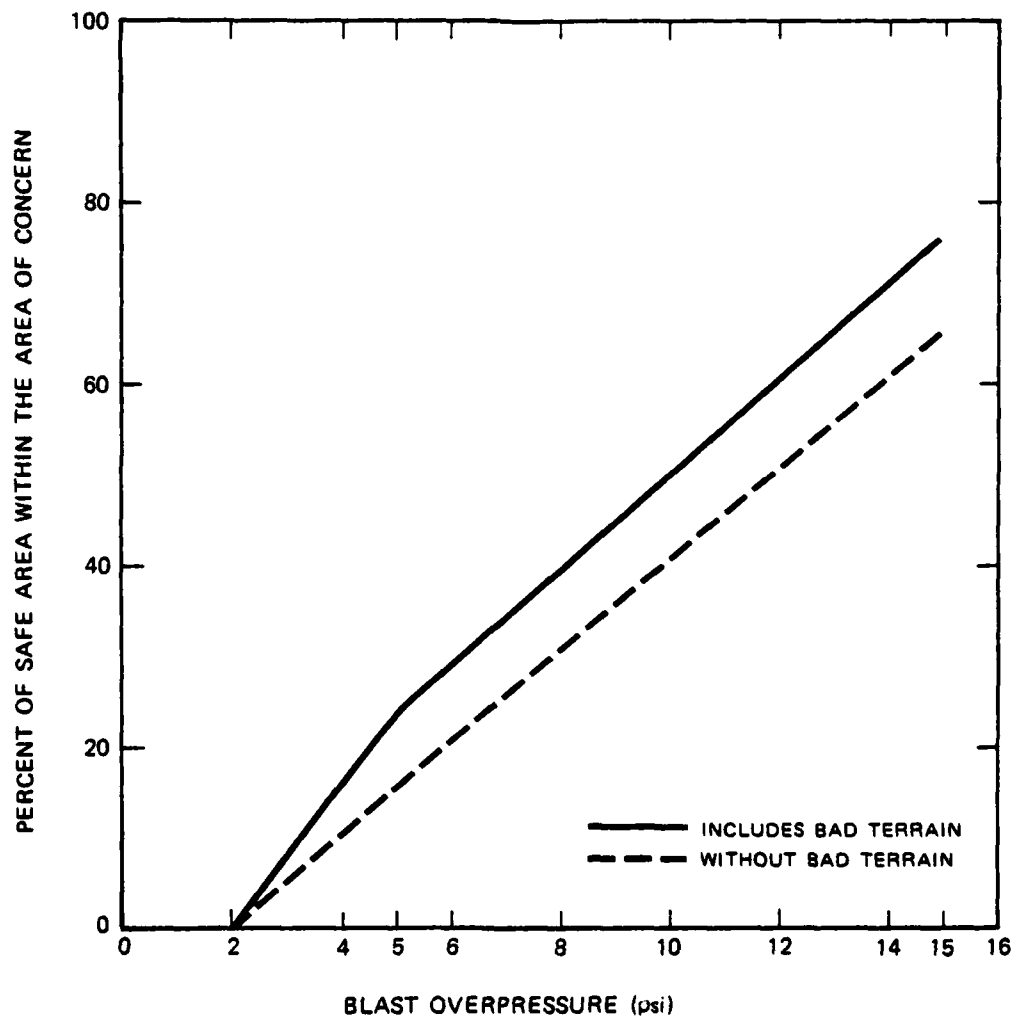


FIGURE 4. SAFE AREA WITHIN AREA OF CONCERN

B. JOHNSON COUNTY

There are approximately 34,000 people in Johnson County. Almost the same percentage of blast damage would be experienced in this county as in Pettis County. As with Pettis, Johnson County would need 5-psi overpressure shelters or 15-psi blast shelters for almost everyone. Figure 5 shows that there are hardly any blast-safe areas in Johnson County; the residents would also need fallout protection.

Approximately 40 percent of the county's population is in the Warrensburg area (pop. 13,125). Most of the population in the Warrensburg area would need 5-psi overpressure shelters and all of the area would need fallout protection.

The major population areas requiring 15-psi blast shelters are: Knob Noster (pop. 2,300); Centerview (pop. 250); Kingsville (pop. 300). There are also another 8,000 people dispersed in the rural areas who would require 15-psi blast shelters; these shelters would have to be centrally located within 15-minute walking distance of the surrounding population.

The major population areas requiring 5-psi overpressure shelters are: Holden (pop. 2,100); LaTour (pop. 100), Chilhowee (pop. 300); Leeton (pop. 450). The remaining population (approximately 6,000 people) would need 5-psi overpressure shelters centrally located among the surrounding populations, all within 15-minute walking distance.

After the blast damage has occurred, the major road network would be damaged; therefore, life support for extended occupancy would be required in Johnson County.

C. MORGAN COUNTY

Morgan County has a population of about 12,300 people. About one-half of the population (6,000) in the southern part of Morgan County are relatively safe from blast, but because this area is downwind from the blast region, a large percent of the time the blast-safe area would require heavy fallout protection. Jacobs Cave is between Versailles and Gravois Mills, is close

JOHNSON COUNTY

AREA OF CONCERN: THE AREA THAT IS AFFECTED
AND BOUNDED BY A 2-psi BLAST OVERPRESSURE

AREA OF COUNTY: 828 mi²

AREA OF CONCERN: 808 mi² (98% OF THE COUNTY)

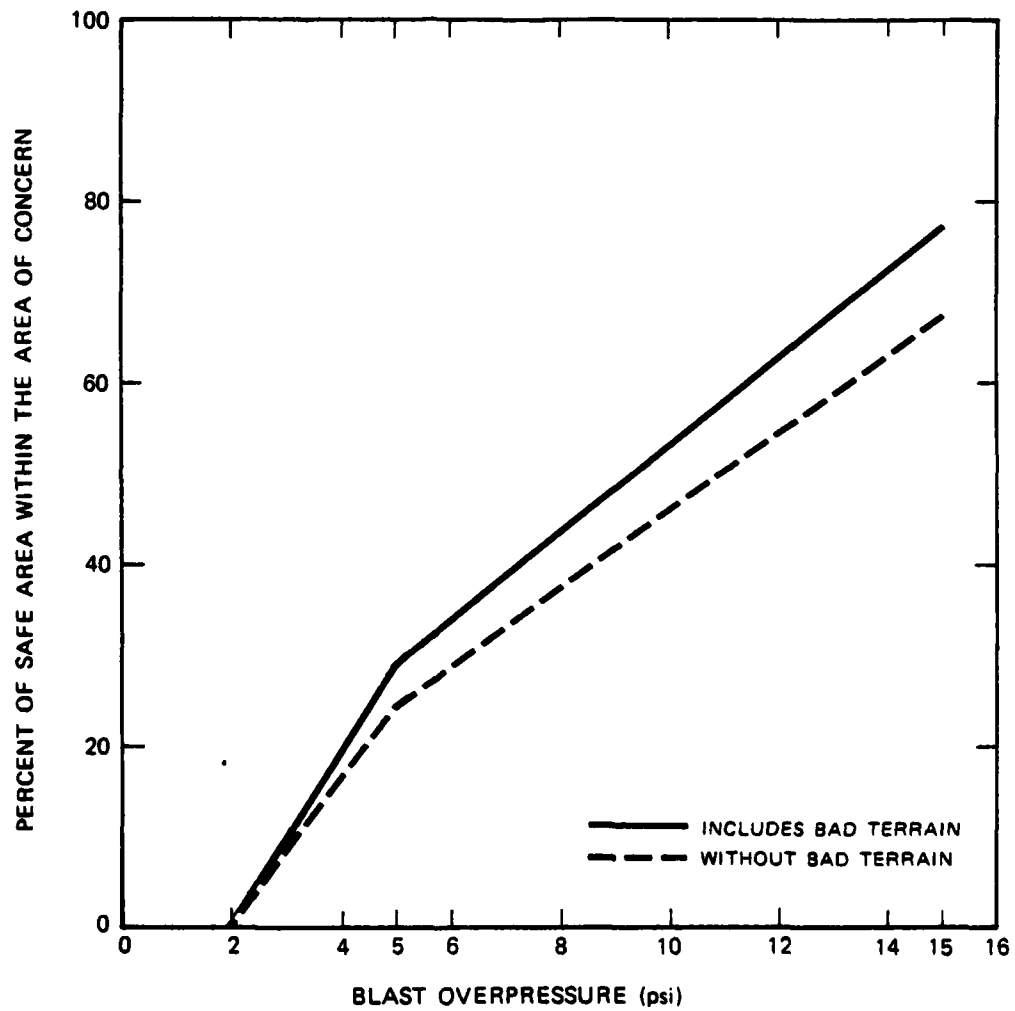


FIGURE 5. SAFE AREA WITHIN AREA OF CONCERN

MORGAN COUNTY

AREA OF CONCERN: THE AREA THAT IS AFFECTED
AND BOUNDED BY A 2-psi BLAST OVERPRESSURE

AREA OF COUNTY: 592 mi²

AREA OF CONCERN: 360 mi² (61% OF THE COUNTY)

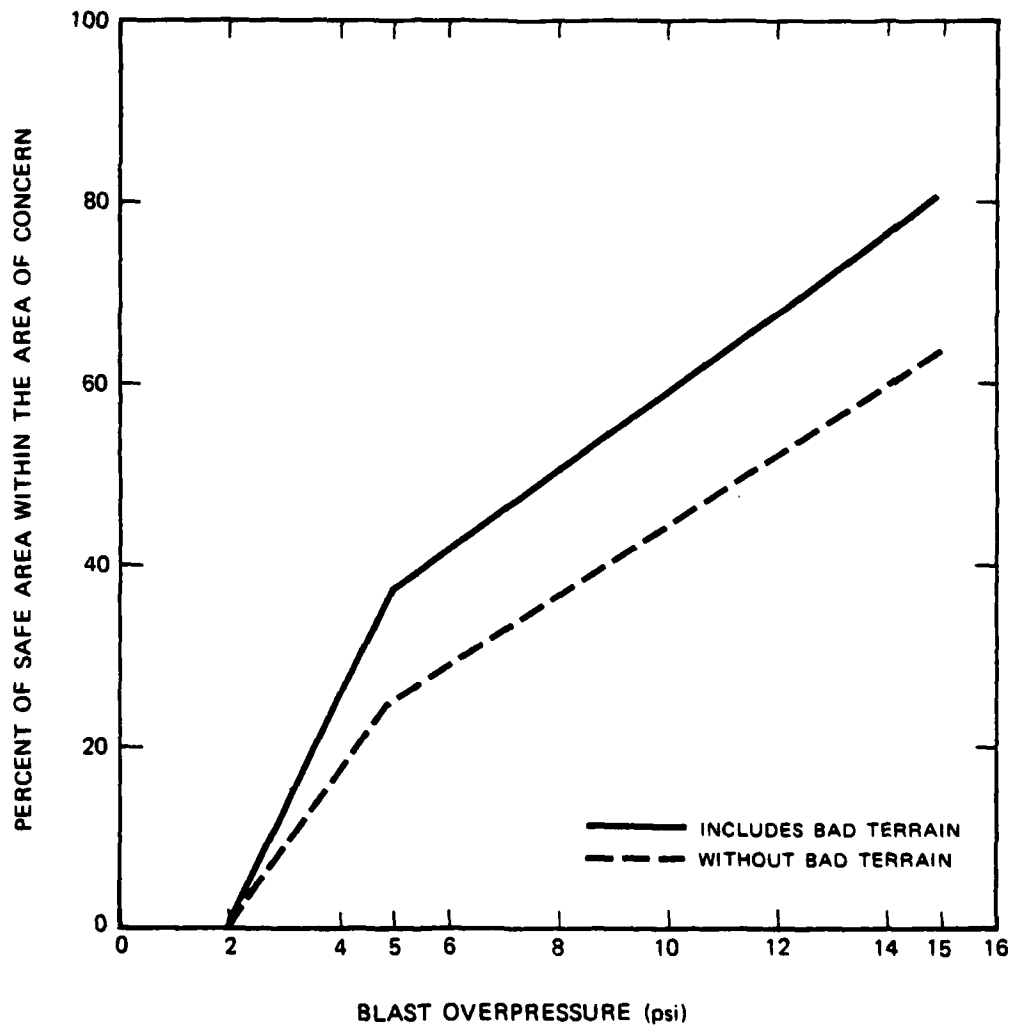


FIGURE 6. SAFE AREA WITHIN AREA OF CONCERN

to good roads, and would be a good place for fallout protection. It would hold approximately 240 people; life support provisions would have to be previously arranged.

A large portion of the southern part of Morgan County contains only seasonal dwellings. All of this area would need fallout protection, but blast protection is not deemed necessary.

The northern part of Morgan County would receive a considerable amount of blast damage. The towns requiring 15-psi blast shelters are: Versailles (pop. 2,244); Stover (pop. 900), Syracuse (pop. 250). About 1,500 people are dispersed among these blast areas; 15-psi blast shelters for them would need to be centrally located and reachable within 15 minutes.

There are also another 1,000 people dispersed in the northern part of Morgan County. They would require 5-psi overpressure shelters for their protection.

D. COOPER COUNTY

Cooper County has a population of about 15,200 people. One-half of the population is in Boonville (7,500). The western half of the town is subject to blast such that 5-psi overpressure shelters would be needed for people living there. People living in the extreme western end of Boonville would require 15-psi blast shelter protection. Eastern Boonville lies in a heavy fallout area and would need fallout protection in the event of a nuclear attack.

The town of Blackwater (pop. 250) would also need blast protection for the people. McDowell Mine, located 1 mile southeast of the town, could be used as a shelter. The mine has room for 6,000 people, although a blast door and forced ventilation would have to be provided. With proper preparation, the mine could be used to protect people of the surrounding area. Approximately 1,000 people could be evacuated to McDowell Mine and still be safe within the 15-minute warning time.

COOPER COUNTY

AREA OF CONCERN: THE AREA THAT IS AFFECTED
AND BOUNDED BY A 2-psi BLAST OVERPRESSURE

AREA OF COUNTY: 568 mi²

AREA OF CONCERN: 390 mi² (69% OF THE COUNTY)

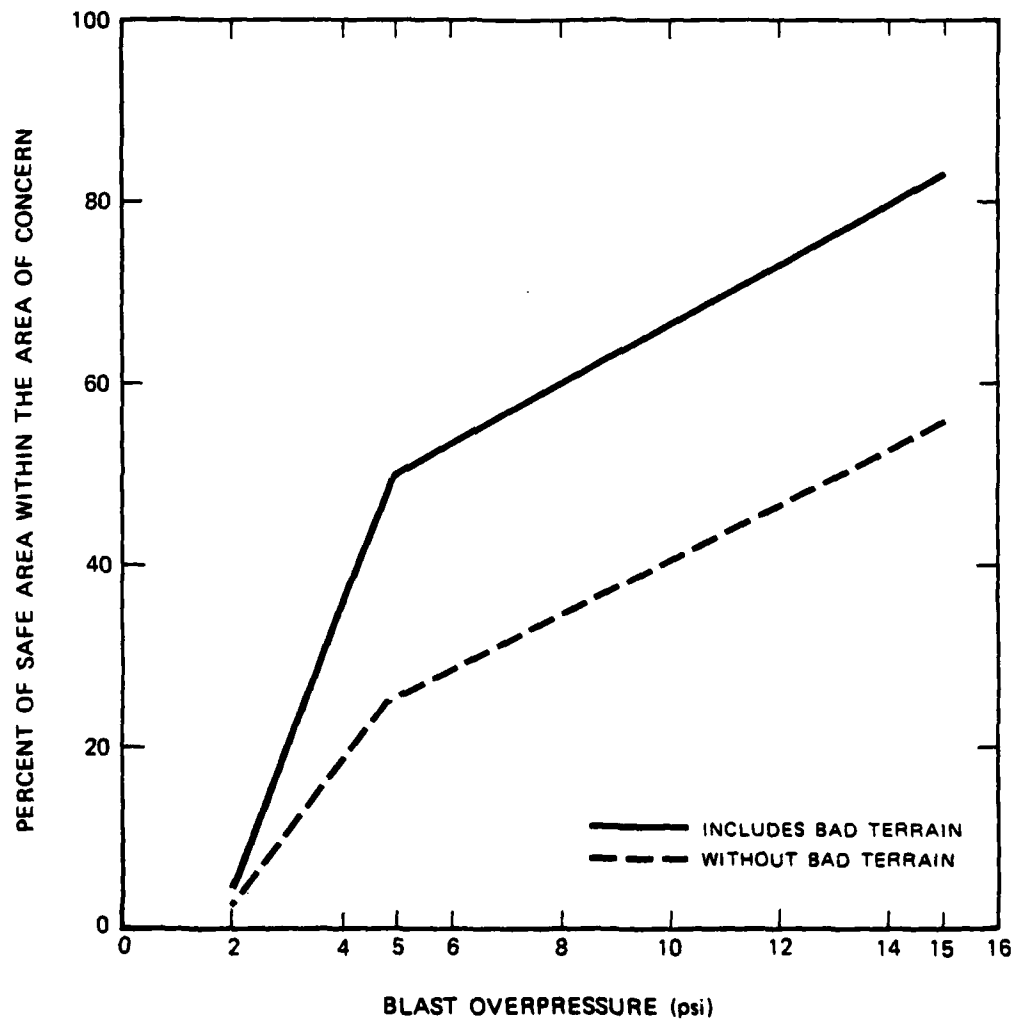


FIGURE 7. SAFE AREA WITHIN AREA OF CONCERN

Other towns needing 15-psi blast shelters are Pilot Grove (pop. 700) and Otterville (pop. 450). Approximately 2,000 people who are dispersed among rural areas will also need 15-psi blast protection. The 15-psi blast shelters will have to be built along good road networks and within a 15-minute walk from where they live.

The eastern part of Cooper County is not within the blast region, but it does lie in a heavy fallout region. Fallout protection would be needed for the 3,500 people who live in this area.

E. HENRY COUNTY

There are approximately 18,800 people in Henry County. Clinton, with a population of 7,500, is located in the center of Henry County and lies in a heavy fallout area, because it is surrounded by heavily concentrated blast areas. Fallout protection for the town will therefore be required. Those living in the southern end of Clinton could possibly use Williams Rock Mine, which is 4 miles southeast of Clinton, as a shelter. The mine can accommodate 14,700 people. Also further south are two more mines, Knisely Quarries and Davies Quarries North Mine. All these mines will be useful in protecting the surrounding communities (approximately 1,500 people) from light blast and heavy fallout damage.

The towns that lie in heavy blast areas and require 15-psi blast shelter protection for the people are: Windsor (pop. 2,750); Calhoun (pop. 360); Blairstown (pop. 200); Urich (pop. 440); Montrose (pop. 530); and Deepwater (pop. 565).

There are approximately 1,000 people who live close to detonation points that would need 15-psi blast or 5-psi overpressure shelters. The remaining 2,000 or more people are in relatively safe areas, but they will have to take fallout precautions because of their proximity to blast areas.

F. SALINE COUNTY

Saline County has a population of 24,300 people. The town of Marshall (pop. 12,100) is located in the center of Saline. Most of the people are

HENRY COUNTY

AREA OF CONCERN: THE AREA THAT IS AFFECTED
AND BOUNDED BY A 2-psi BLAST OVERPRESSURE

AREA OF COUNTY: 734 mi²

AREA OF CONCERN: 734 mi² (100% OF THE COUNTY)

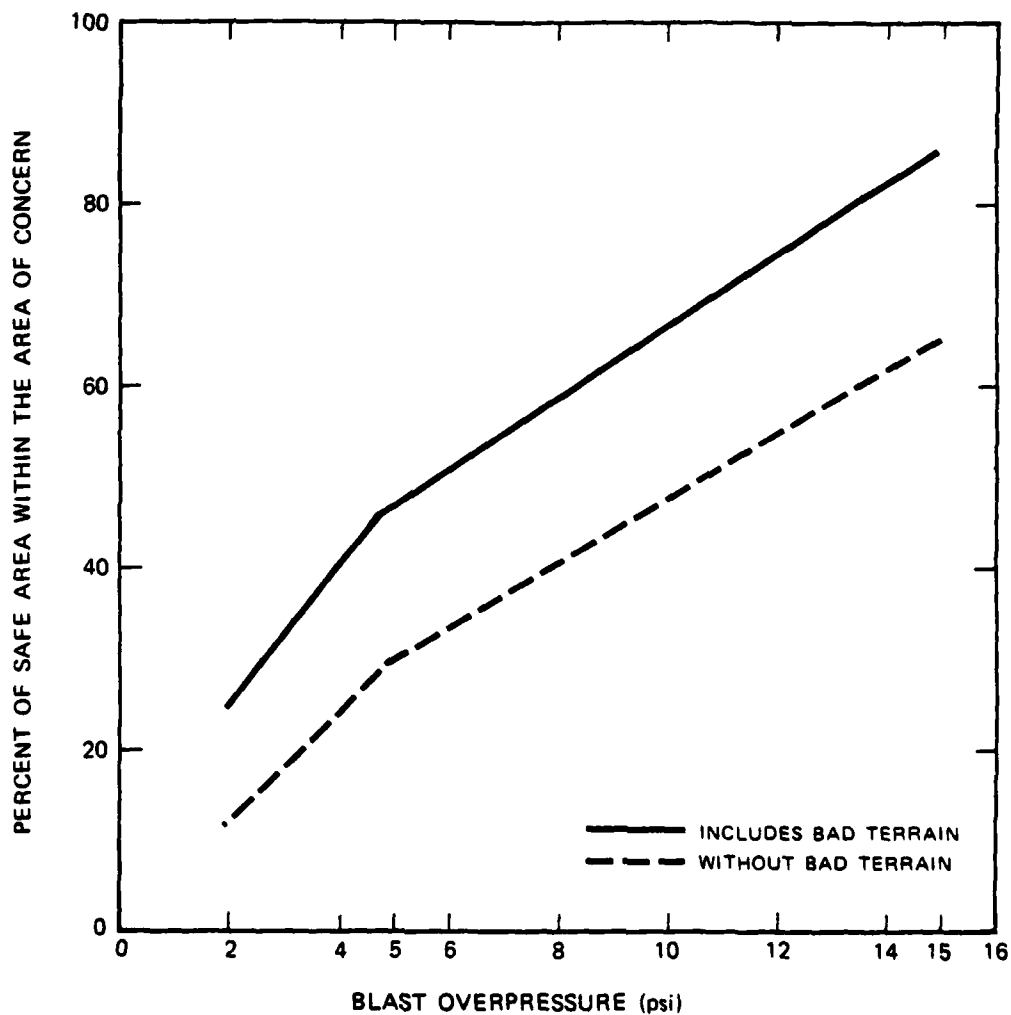


FIGURE 8. SAFE AREA WITHIN AREA OF CONCERN

SALINE COUNTY

AREA OF CONCERN: THE AREA THAT IS AFFECTED
AND BOUNDED BY A 2-psi BLAST OVERPRESSURE

AREA OF THE COUNTY: 757 mi^2

AREA OF CONCERN: 340 mi^2 (45% OF THE COUNTY)

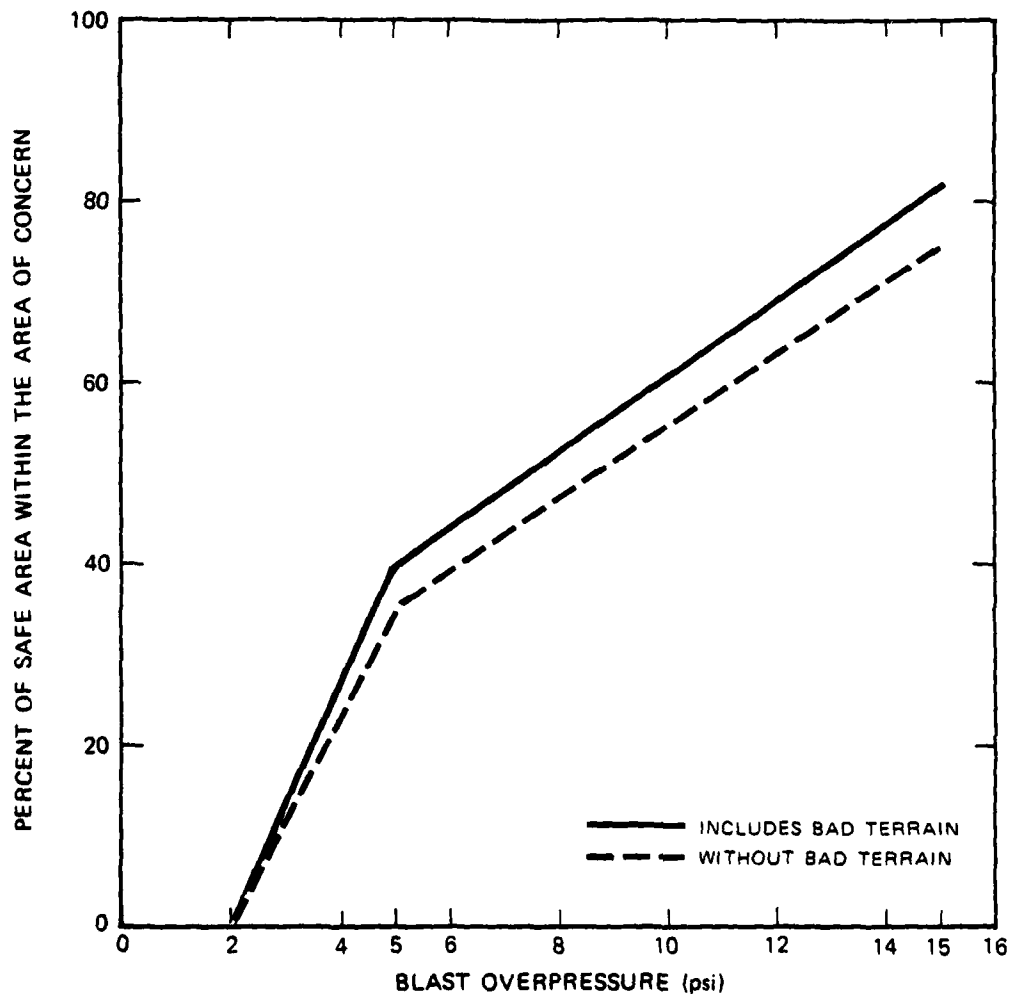


FIGURE 9. SAFE AREA WITHIN AREA OF CONCERN

relatively safe from blast damage, but because of the blast areas in the southwest, the town will sustain heavy fallout. All of northern Saline County is relatively safe from blast, but fallout precautions will nonetheless be necessary in the event of a nuclear attack.

The southern part of Saline County has numerous blast areas. The major populated areas needing blast shelters are: Sweet Springs (pop. 1,700); Blackburn (pop. 300); and Nelson (pop. 230). There are approximately 4,000 people dispersed in the rural areas who are in potential blast areas. In some of these areas, a 15-psi blast shelter or 5-psi overpressure shelter would be necessary for protection from blast.

G. ST. CLAIR COUNTY

St. Clair County has a population of approximately 9,000 people. It is mainly a rural county, and most of its population is dispersed in blast areas. The major population areas needing 15-psi blast shelters are Appleton City (pop. 1,058); Lowry City (pop. 520); Roscoe (pop. 140); Collins (pop. 150); and Vista (pop. 50).

The town of Osceola (pop. 900) lies in an area that would need 5-psi overpressure shelters for protection. Just 1 mile west of Osceola is Hunt Limestone Mine. The mine would be an excellent shelter for a good portion of the people of Osceola. The mine can accommodate 1,610 people, so people from the surrounding area could also find shelter there. Hunt Mine will require some preparation, however, in order to be used to withstand 5-psi overpressure.

The eastern one-fourth of St. Clair County and the communities surrounding Monegaw Springs are relatively free from blast damage. Because of their close proximity to the major blast areas, the people living in these areas would still be required to take fallout protection procedures.

The remaining population (3,000 people) are scattered in rural areas of St. Clair County. Most of these areas are in the blast region, and

ST. CLAIR COUNTY

AREA OF CONCERN: THE AREA THAT IS AFFECTED
AND BOUNDED BY A 2-psi BLAST OVERPRESSURE

AREA OF COUNTY: 697 mi²

AREA OF CONCERN: 559 mi² (80% OF THE COUNTY)

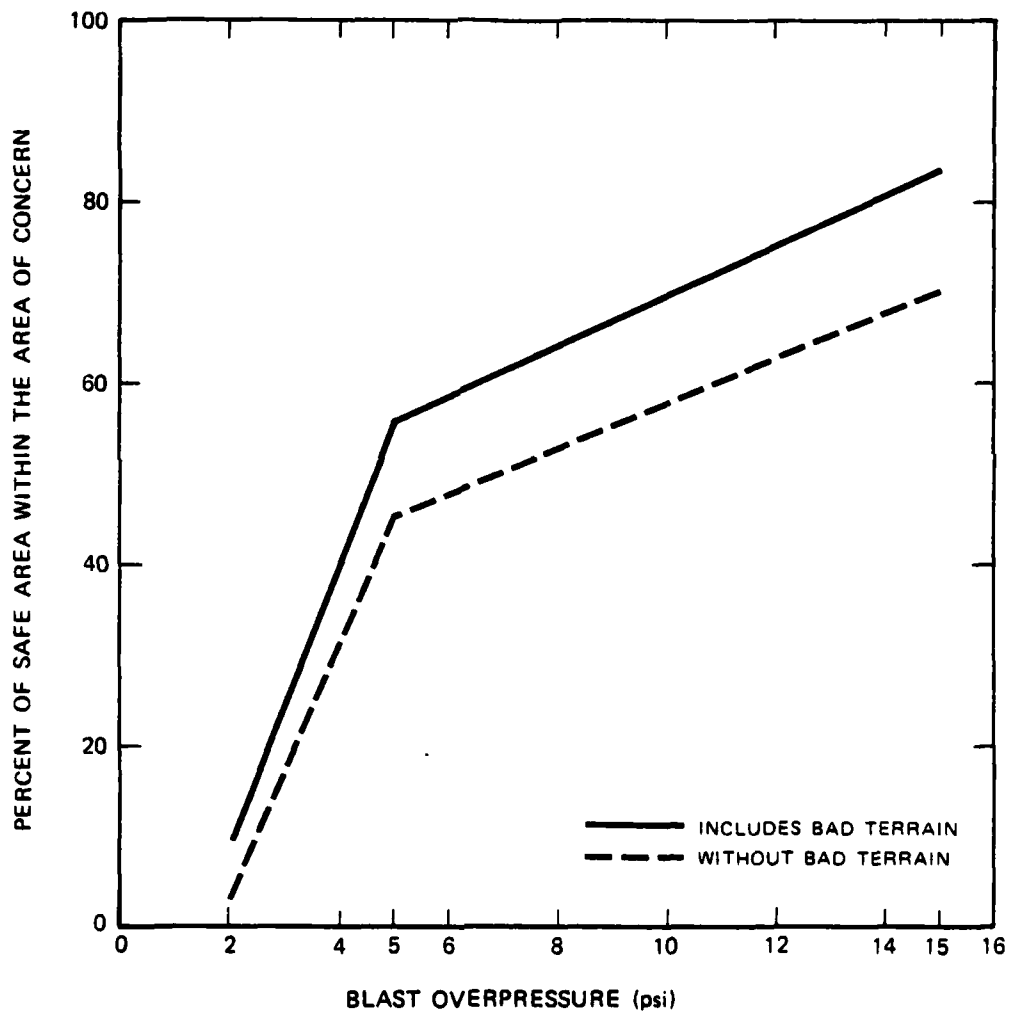


FIGURE 10. SAFE AREA WITHIN AREA OF CONCERN

people living there would need 15-psi blast shelters or 5-psi overpressure shelters.

H. BATES COUNTY

Bates County has a population of 16,200 people. The county would suffer from considerable blast damage. Fifteen-psi blast shelters would be required in much of the county. Life support for extended occupancy would be necessary. Fallout (without blast) in Bates County would be mainly experienced by those living in the northeast corner of Bates, and its severity would depend on wind direction.

The cities and towns that would only require a 5-psi overpressure shelter are: Butler (pop. 4,000); Merwin (pop. 100); Amsterdam (pop. 200); Papinsville (pop. 50); and Johnstown (pop. 50).

Within the blast region of concern in this study, approximately 5,000 people are dispersed in small rural communities. In some of these areas, it would be necessary to place a 15-psi blast shelter or 5-psi overpressure shelter in a central location so that the people are within a 15-minute walk to the shelter.

I. LAFAYETTE COUNTY

Lafayette County has a population of about 29,000 people. Almost the entire county receives a high concentration of blast damage. The major populated areas that would require 15-psi blast shelters for protection are: Higginsville (pop. 4,400); Corder (pop. 500); Concordia (pop. 1,900); Emma (pop. 250); Odessa (pop. 2,850); Mayview (pop. 330); and Aullville (pop. 120).

Alma (pop. 400), a populated area located further from detonation points, would require 5-psi overpressure shelters.

A large portion of Lafayette's population is in the northern part of the county along the Missouri River. Approximately 9,000 people live along the river, and all these people are relatively safe from blast and fallout.

BATES COUNTY

AREA OF CONCERN: THE AREA THAT IS AFFECTED
AND BOUNDED BY A 2-psi BLAST OVERPRESSURE

AREA OF COUNTY: 841 mi²

AREA OF CONCERN: 618 mi² (73.5% OF THE COUNTY)

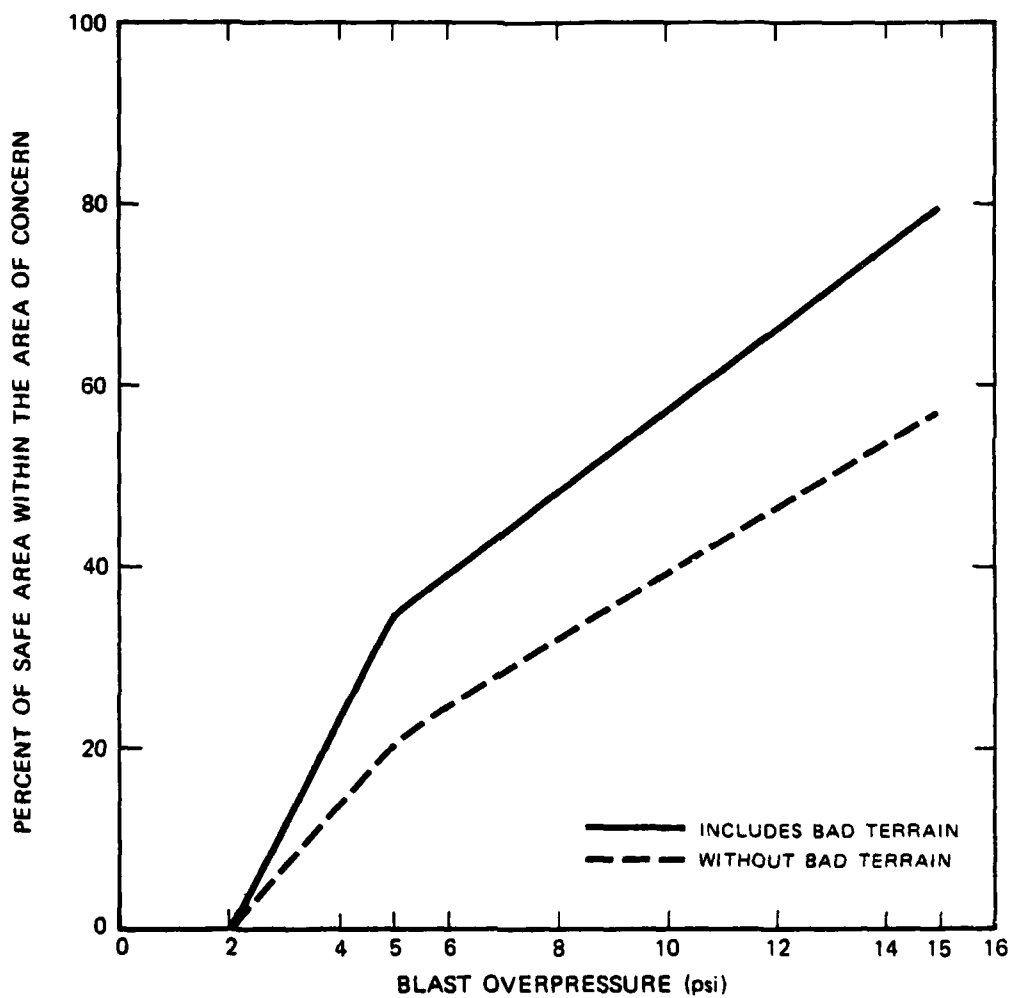


FIGURE 11. SAFE AREA WITHIN AREA OF CONCERN

LAFAYETTE COUNTY

AREA OF CONCERN: THE AREA THAT IS AFFECTED
AND BOUNDED BY A 2-psi BLAST OVERPRESSURE

AREA OF COUNTY: 632 mi²

AREA OF CONCERN: 480 mi² (75% OF THE COUNTY)

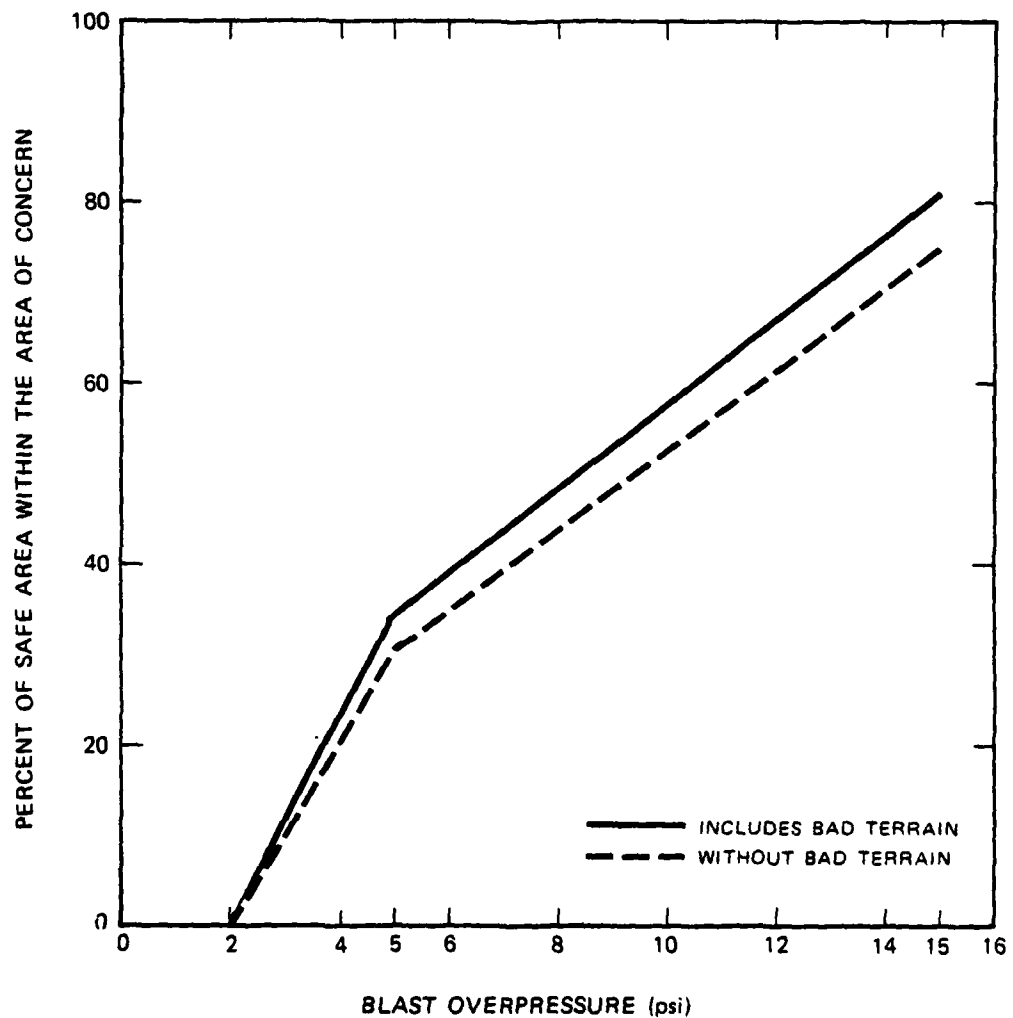


FIGURE 12. SAFE AREA WITHIN AREA OF CONCERN

The remaining 8,000 or 9,000 people are scattered in small communities throughout the blast area. Those along the northern edge of the blast region can evacuate to the north along the Missouri River. Those people living in the southern blast damage areas of Lafayette County would require 15-psi blast or 5-psi overpressure shelters. The shelters would have to be located within a 15-minute walking distance from the surrounding population.

J. BENTON COUNTY

Benton County has a population of about 11,800 people. The county receives its only blast damage in the northern part of the county.

Populated areas that would require 15-psi blast shelters to protect the people from any harm due to the possibility of blast in the area are: Lincoln (pop. 600); Cole Camp (pop. 1,050); and Ionia (pop. 175).

There are also approximately 2,500 people in small rural communities in the northern Benton County blast area. Most of these people can evacuate to the southern portion of the county and be provided fallout protection.

Approximately 60 percent of Benton County's population (7,000 people) are not in blast regions. They are in the southern sections of Benton County, with high concentrations along the Lake of the Ozarks. This region is east of the blast regions in St. Clair, but close enough to these regions that fallout protection would be required.

K. MONITEAU COUNTY

Moniteau has a population of about 11,800 people. The western sections of Moniteau County receive some blast damage. Most of the people in this western region can evacuate to the eastern part of Moniteau to be safe from effects of the blast. Two major populated areas in this blast region may not be able to evacuate to the east; 15-psi blast shelters are therefore required for the people in those areas. The two towns are: Tipton

BENTON COUNTY

AREA OF CONCERN: THE AREA THAT IS AFFECTED
AND BOUNDED BY A 2-psi BLAST OVERPRESSURE

AREA OF COUNTY: 735 mi²

AREA OF CONCERN: 305 mi² (41% OF COUNTY)

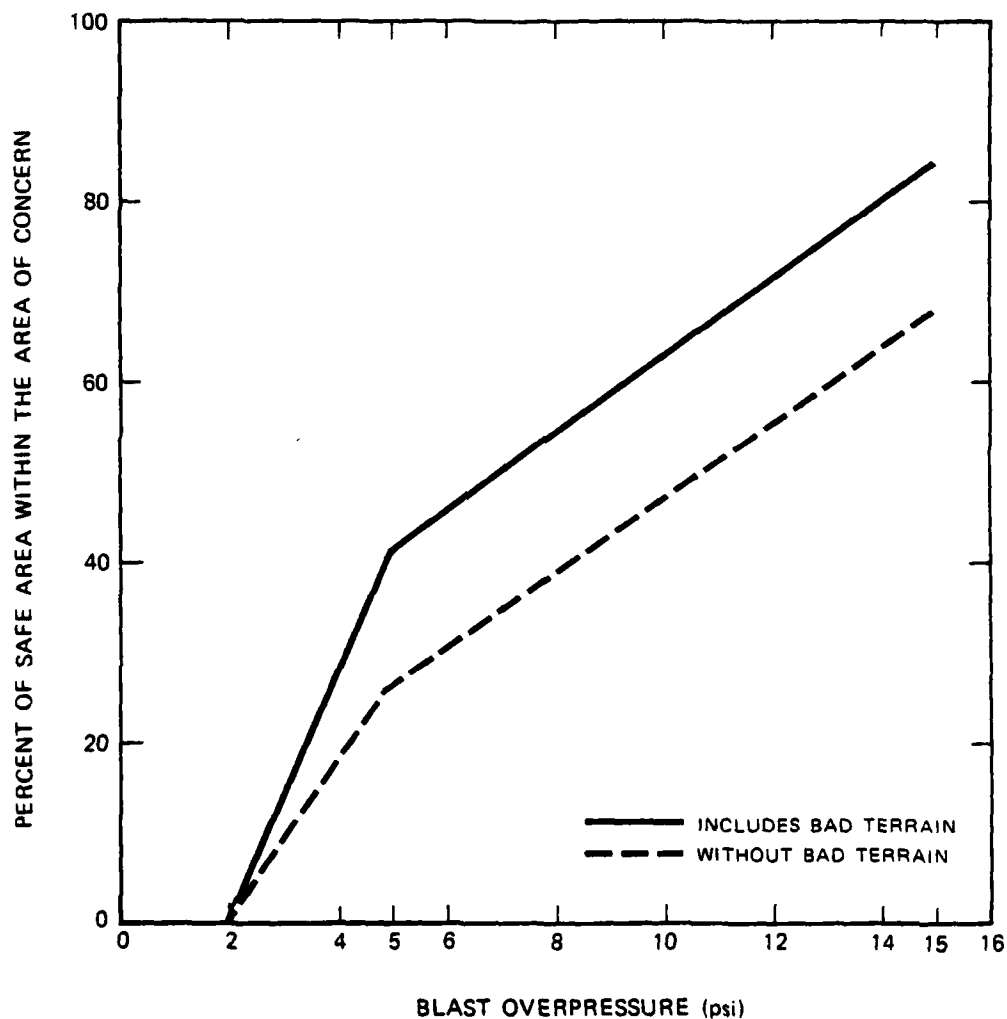


FIGURE 13. SAFE AREA WITHIN AREA OF CONCERN

MONITEAU COUNTY

AREA OF CONCERN: THE AREA THAT IS AFFECTED
AND BOUNDED BY A 2-psi BLAST OVERPRESSURE

AREA OF COUNTY: 419 mi²

AREA OF CONCERN: 130 mi² (31% OF COUNTY)

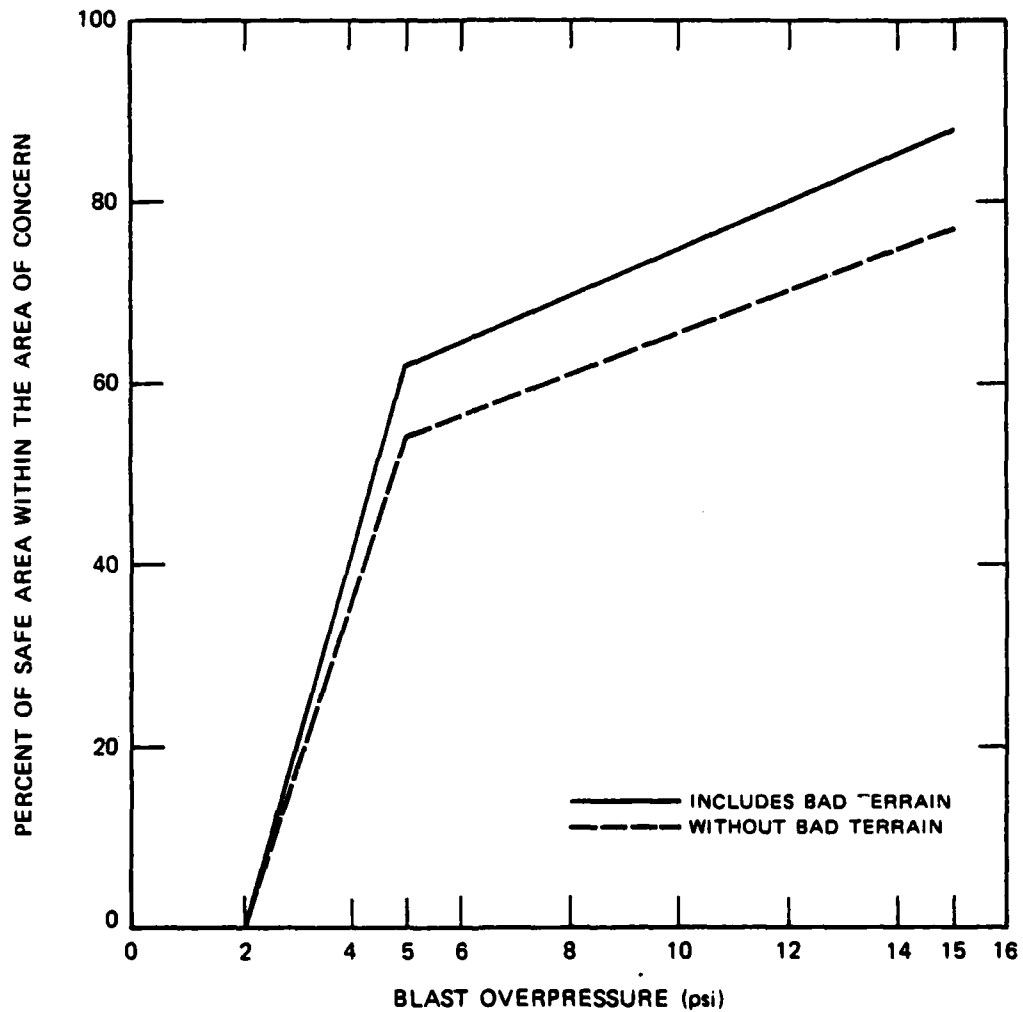


FIGURE 14. SAFE AREA WITHIN AREA OF CONCERN

(pop. 1,925); and Clarksburg (pop. 350). Because Moniteau lies east of blast areas and in the direction of most seasonal wind patterns, the remainder of the county would have to take heavy fallout protection.

L. CEDAR COUNTY

The population of Cedar County is approximately 11,300 people. The northwestern portion of the county would receive blast damage and the entire north-central portion would receive fallout. Most of the people in this region can be evacuated to the southwestern corner of the county, which is relatively safe from both blast damage and radiation. The only exception to this evacuation pattern is in Eldorado Springs (pop. 3,300), which is located in the very northwest corner of the county. With limited warning, a large flux of people out of the town may not be possible, so some 5-psi overpressure shelters may be needed. Also, some people in rural areas in Cedar County's blast region may need some shelter protection if they cannot get out of the region given limited warning.

M. VERNON COUNTY

Vernon County's population is approximately 20,000 people. The eastern one-third of the county will receive blast damage, but the western regions of the county are relatively safe from blast damage and would probably receive little radiation. Therefore, evacuation of the eastern sections of the county to the western sections is a possible fallout protection measure.

Some of the more populated areas in eastern Vernon County may consider putting a few 5-psi shelters in the areas in case a large flux of people could not get out of the area given limited warning. Two towns that should have such shelters are: Schell City (pop. 400), and Harwood (pop. 100).

Vernon County is west of all of the major blast areas; therefore, a large percent of the time no evacuation from radiation is necessary. Figure 16 shows that within the area of concern there are hardly any safe

CEDAR COUNTY

AREA OF CONCERN: THE AREA THAT IS AFFECTED
AND BOUNDED BY A 2-psi BLAST OVERPRESSURE

AREA OF COUNTY: 496 mi²

AREA OF CONCERN: 195 mi² (39% OF COUNTY)

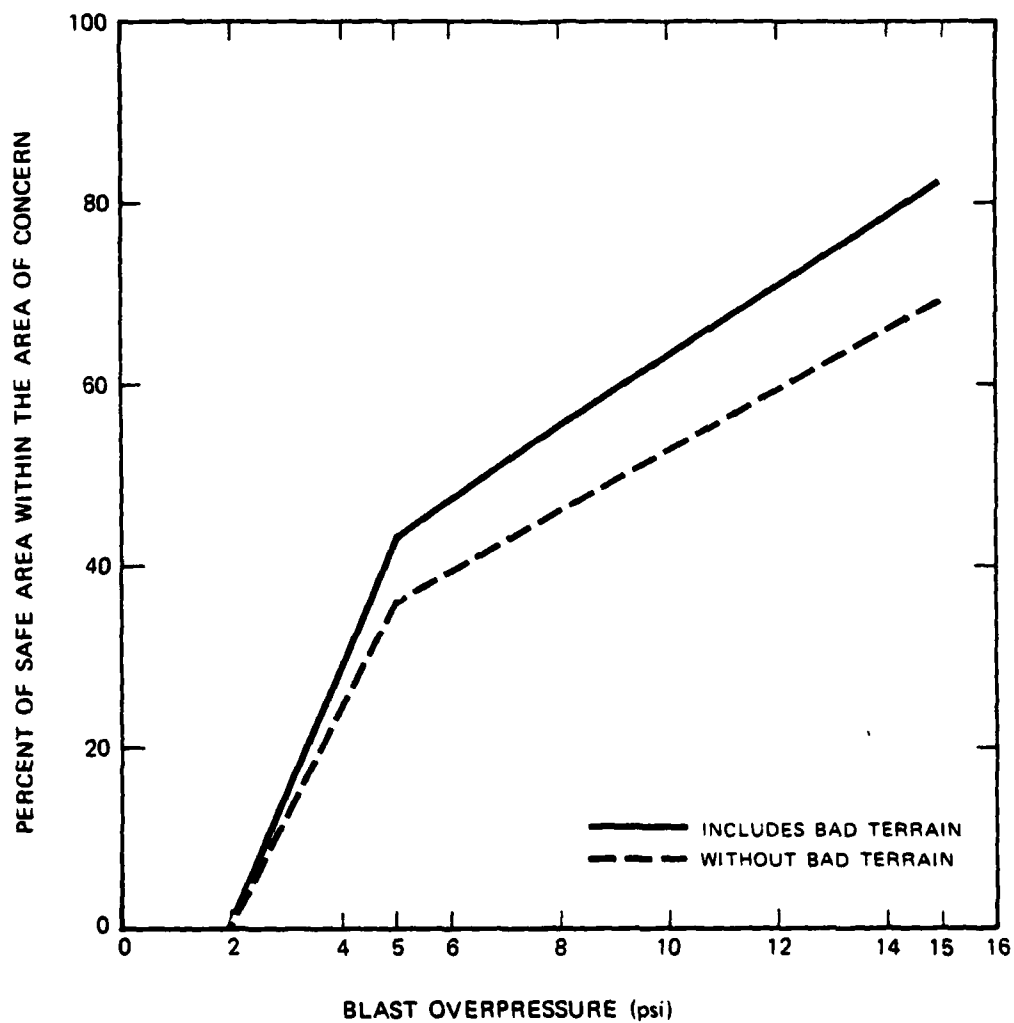


FIGURE 15. SAFE AREA WITHIN AREA OF CONCERN

VERNON COUNTY

AREA OF CONCERN: THE AREA THAT IS AFFECTED
AND BOUNDED BY A 2-psi BLAST OVERPRESSURE

AREA OF THE COUNTY: 838 mi²

AREA OF CONCERN: 200 mi² (24% OF THE COUNTY)

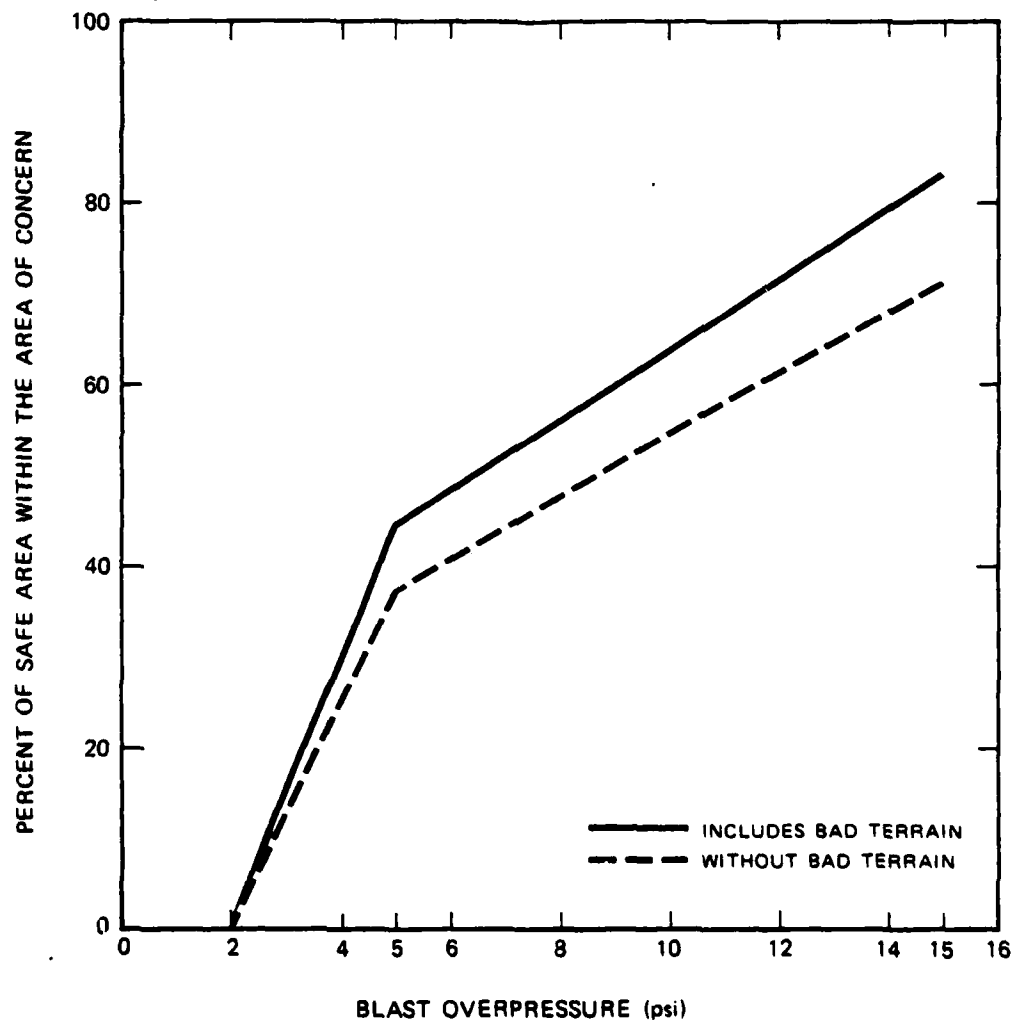


FIGURE 16. SAFE AREA WITHIN AREA OF CONCERN

areas. This still would not make relocation of the population hard to accomplish, because most people are close to the western blast-free sections of the county.

N. CASS COUNTY

The population of Cass County is approximately 48,500 people. The southwestern corner of the county receives considerable blast damage. Most of Cass County is west of the Minuteman silos and would probably not have to adopt fallout protection.

Most people living in the blast damage areas of Cass County can evacuate to the northwest sections of the county. There are two large mines in the northwest section of the county: McKee Quarries and Hackler and Limpus Mine. These mines are out of the blast and fallout regions. People of Cass County would need to evacuate to these mines only in the event of wind blowing from the east during a nuclear attack.

One other mine in Cass County is located in a rural blast area near Everett and Main City. With some preparation, this mine would be a useful shelter for the people in the nearby area.

Two populated areas in the blast region of Cass County may consider having shelters built to hold some of the population who cannot get out of the area given a limited warning. The first town, Archie (pop. 550), would need 5-psi overpressure shelters to provide protection for people in the area. The second town, Garden City (pop. 650), would need 15-psi blast shelters.

O. HICKORY COUNTY

Hickory County has a population of approximately 6,000 people. This county receives almost no blast damage and is only mentioned for fallout purposes. The county lies east of major blast damage areas and therefore is subject to heavy fallout. In the event of a nuclear attack on the Minuteman silos, residents in Hickory should adopt fallout protection.

CASS COUNTY

AREA OF CONCERN: THE AREA THAT IS AFFECTED
AND BOUNDED BY A 2-psi BLAST OVERPRESSURE

AREA OF COUNTY: 698 mi²

AREA OF CONCERN: 260 mi² (37% OF THE COUNTY)

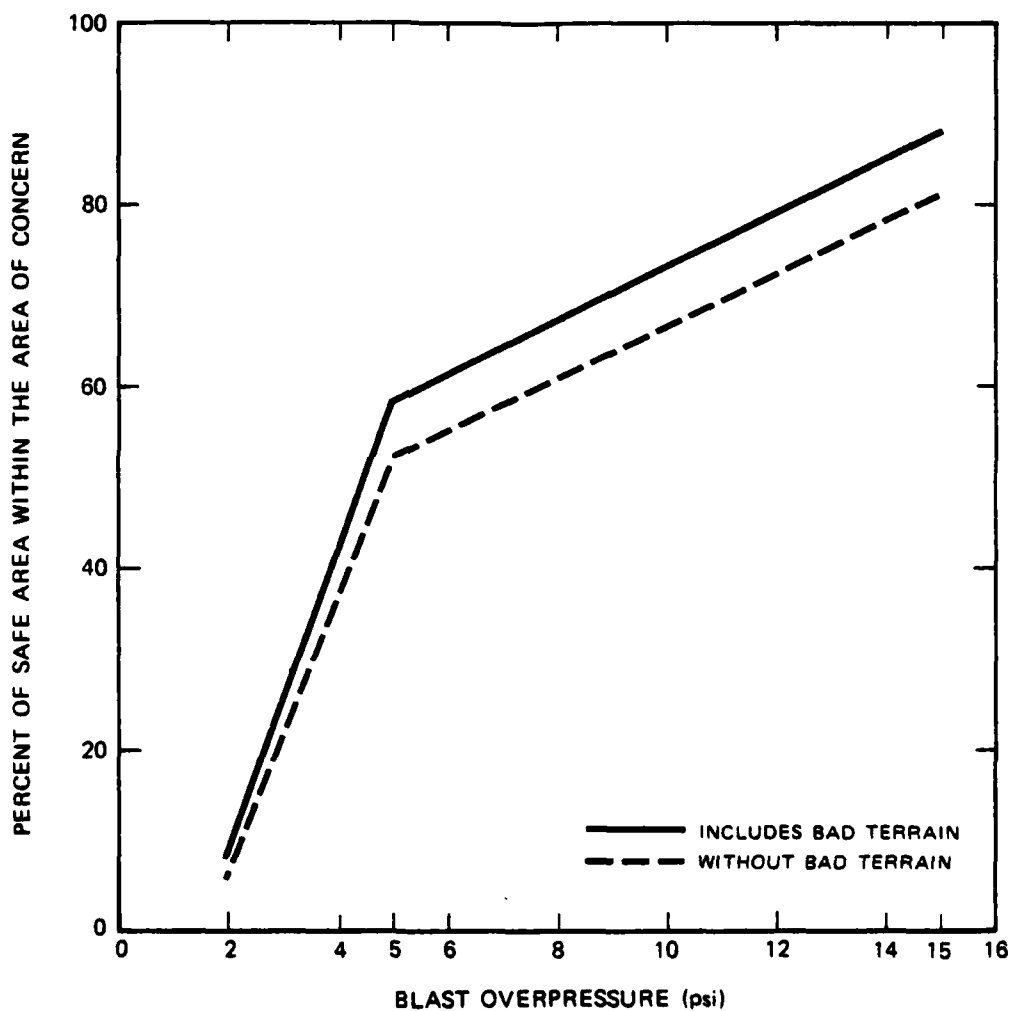


FIGURE 17. SAFE AREA WITHIN AREA OF CONCERN

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1. R. J. Sullivan et al., Civil Defense Needs of High Risk Areas in the United States, System Planning Corporation, SPC Report 409, March 1979.
2. R. J. Sullivan et al., Candidate U.S. Civil Defense Programs, System Planning Corporation, SPC Report 342, March 1978.

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The Local Environment Resulting From A Massive Nuclear Attack on Whiteman Air Force Base, by Charles L. Hulburt, Cynthia A. Yutko and Roger J. Sullivan. (SPC Report 537), UNCLASSIFIED, System Planning Corporation, Arlington, Virginia 22209, April 1980, 55 pages, (Contract DCPA01-78-C-0280, Work Unit Number 4222E).

Abstract

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